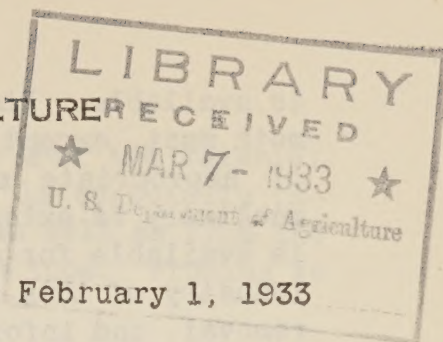


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UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ENTOMOLOGY
WASHINGTON, D. C.



To Experiment Station
and State Entomologists:

(NOT FOR PUBLICATION)

MEMORANDUM RE CODLING MOTH CONTROL AND SPRAY RESIDUE

A letter addressed by the Department to State entomologists, State Agricultural colleges, experiment stations, and extension services under date of January 20, 1933, a copy of which has already been mailed to you from the Bureau of Entomology, discusses the present situation as to spray residue with special reference to the lead residue resulting from using lead arsenate and to certain problems of residue on leafy vegetables. This letter was supplemental to a letter of July 6, 1932, stressing the danger to human health from excessive arsenical residues and the similar risk from inorganic fluorine compounds.

The letter of January 20, 1933, urges all technical and extension agencies concerned to endeavor to secure the adoption, by growers, of spray schedules and methods of application recommended by the proper State and Federal agencies. It indicates also that several bureaus of this Department will supply additional and more detailed information on spray-residue problems both as to schedules and effective methods of residue removal. In compliance with this promise, the Bureau of Entomology has drafted two memoranda, in relation to the spray residue problems, one dealing specifically with the codling moth control and the other dealing with vegetable crops, certain small fruits, and tobacco. The recommendations in these memoranda are based on conferences with the Bureau's station leaders in these two fields of work and are, therefore, a report of the experience and information of the Bureau. These statements necessarily are subject to modification to meet varying field conditions and the results of studies now in progress.

The problems involved in codling moth control by spraying vary so much in different sections that specific schedules are limited in their application. For this reason, no effort will be made to offer recommendations for all sections of the country. Definite statements will be made, however, for a few representative orchard districts. Only the insecticidal portions of schedules are referred to; fungicides and lime should be added in accordance with local practice.

CONTROL BY SPRAYING

Lead arsenate and residue removal.--The use of lead arsenate in much of the spray program seems unavoidable until an adequate substitute

is available. Its use in a spray program adequate to control the codling moth must, except in a few favored regions, be followed by the employment of appropriate methods of removing the poisonous residue. Washing machinery is extensively used in the Pacific Northwest and elsewhere, and is available for adoption wherever it may be needed. The Bureau of Plant Industry of this Department is actively investigating methods of residue removal, and information on this subject will be supplied by that bureau.

Mineral oil and fish oil.--Mineral-oil emulsions add to the effectiveness of lead arsenate in the control of the codling moth but increase the quantity of residue present at harvest time and the difficulty of removing residues. In many cases this has necessitated the use of alkaline washes, some of which, although satisfactory for arsenic, are less effective in removing lead. If mineral oil is used with lead arsenate, it should be restricted to the first brood. Mineral oil should not be combined with sulphur sprays or applied too soon after the application of sulphur sprays or dusts. Fish oil and linseed oil have, in most cases, increased the effectiveness of lead arsenate. As with mineral oil, however, their use should be restricted to the first-brood period, particularly if acid is to be used for cleaning the fruit.

Non-lead arsenicals.--Many non-lead arsenicals have been tested in recent years, but none of them has given control as satisfactory as that obtained with lead arsenate. Of these materials, calcium arsenate has shown the most promise, but it can not be recommended unless local experience has indicated that it gives satisfactory results. The Bureau of Entomology, in cooperation with the Bureau of Chemistry and Soils, proposes immediately to undertake field and laboratory tests with arsenicals of other types with the hope that some of these may be substituted for lead arsenate.

Nicotine sulphate.--A good deal of experimentation has been carried out in laboratory and orchard with the use of a nicotine-oil combination, and although this does not remain effective as long as lead arsenate, especially in humid regions, for the present it seems the most satisfactory substitute for lead arsenate, and its use in late summer sprays is suggested. It does not leave an objectionable residue and will not interfere with the removal of lead arsenate previously applied. It may require a greater number of applications, but the increased cost will in part be offset by other benefits such as the control of sucking insects and mites.

Early applications important.--The strongest possible emphasis should be placed on the control of the first brood, in order to prevent serious increase in later broods. For this early period, lead arsenate is undoubtedly the most effective spray and can be employed at this time with the least risk of leaving a harmful residue. The fruit is small and will carry over relatively little of the spray to the time of harvest. The use of lead arsenate should as far as possible be confined to these early sprays.

Thoroughness and timeliness essential.--Emphasis must also be placed on thoroughness and timeliness of application. The early sprays

in particular should be very carefully timed in order that the material may accomplish the maximum of results. The calyx spray is especially important. The trees should be sprayed from the inside as well as from the outside, and particular attention should be paid to the tops. Pruning to open up the trees will facilitate thorough spraying.

RECOMMENDATIONS FOR THE PACIFIC NORTHWEST AND ROCKY MOUNTAIN REGION

Control of the codling moth in the Pacific Northwest and Rocky Mountain region usually requires a heavy spray schedule, and washing of the fruit is necessary in order to render it marketable. There is a great variation in the number of spray applications needed in the various sections, but the following suggestions are offered which should enable the grower to control the codling moth and at the same time clean the fruit satisfactorily. These suggestions are based on a schedule calling for a calyx and six cover sprays. It should be understood that under conditions of light infestation a reduced schedule may be adequate.

Lead arsenate may be used for all applications where necessary, if limited to not more than 2 pounds to 100 gallons after July 1, and if harvested fruit is thoroughly washed. Fish oil may be added to any of the lead arsenate sprays if tests now being made show that sodium silicate removes the lead residue satisfactorily. Mineral oil may also be used with the lead arsenate, but this combination must be restricted to the sprays for the first brood.

For applications after July 1, the lead arsenate may be replaced by nicotine sulphate, employed with an oil emulsion. In the arid sections, cryolite, with oil emulsion, may also be used, but only as a temporary expedient, because fluorine, according to present indications, is fully as objectionable from a residue standpoint as lead. Removal of nicotine residues is not necessary, but residues from cryolite must be removed.

The following schedules embody most of these suggestions:

<u>Spray applications 1/</u>	<u>Schedule 1</u>	<u>Schedule 2</u>
Calyx.....	Lead arsenate 2 lbs. to 100 gallons.	Lead arsenate 2 lbs. to 100 gallons.
First cover.....	Lead arsenate 3 lbs. to 100 gallons.	Lead arsenate 3 lbs. to 100 gallons.
Second cover.....	Lead arsenate 2 lbs. to 100 gallons; min- eral oil emulsion containing 3/4% oil.	Lead arsenate 2 lbs. to 100 gallons; min- eral oil emulsion containing 3/4% oil.
Third cover.....	Lead arsenate 3 lbs. to 100 gallons.	Lead arsenate 2 lbs. to 100 gallons; min- eral oil emulsion containing 3/4% oil.
Fourth cover.....	Nicotine sulphate 1-1,200; mineral oil emulsion containing 3/4% oil.	Lead arsenate 2 lbs. to 100 gallons; fish oil 1/4%. 2/
Fifth cover.....	do.	do.
Sixth cover.....	do.	do.

1/ See Farmers' Bulletin No. 1326 for information as to the timing of these cover sprays.

2/ Fish oil may be used safely only if an efficient alkaline wash is found.

RECOMMENDATIONS FOR THE OZARKS AND ARKANSAS VALLEY

Control of the codling moth in the Arkansas and Missouri Ozarks and in southern Kansas orchards usually requires usage of maximum strengths of insecticides and a full number of spray applications. This condition demands the employment of lead arsenate until further experimental work offers a better remedy. Such methods result in excessive residues. This means that the fruit, to be safe for human consumption, must be thoroughly cleaned by washing.

Present information indicates that spray residue removal may be accomplished only with the most effective equipment available. The use of lead arsenate in spray schedules at heavy dosages such as 2-50 would require extreme thoroughness in cleaning the fruit at harvest. The addition of oil emulsion to any cover spray increases the amount of residue and the problem of adequate removal.

A spray schedule of lead arsenate at 2-50 for the calyx and three cover sprays in the first brood and of lead arsenate at 1 1/2-50 in four cover sprays for the second and later broods should provide control of the insect in normal seasons and allow for satisfactory residue removal by washing.

A second spray schedule, similar to Schedule 1, except for a different attack against the first brood, is suggested. Mineral oil emulsion 1%, with lead arsenate 1-50 in the second and third cover sprays, substituted for lead arsenate at 2-50 as used in the previous schedule, should afford more effective control of the insect without increasing the difficulty of residue removal.

As a possible alternative program which will reduce the residue to the point where it may more readily be removed, it is suggested that nicotine sulphate in combination with mineral oil emulsion be substituted for lead arsenate in the last three sprays.

<u>Spray applications</u>	<u>Schedule 1</u>	<u>Schedule 2</u>	<u>Schedule 3</u>
Calyx.....	Lead arsenate 2-50	Lead arsenate 2-50	Lead arsenate 2-50
First cover.....	do.	do.	do.
Second cover.....	do.	Lead arsenate 1-50 + mineral oil emul- sion 1%	do.
Third cover.....	do.	do.	do.
Fourth cover.....	Lead arsenate 1 1/2-50	Lead arsenate 1 1/2-50	Lead arsenate 1 1/2-50
Fifth cover.....	do.	do.	Mineral oil emul- sion 1% + nicotine sulphate 1-800
Sixth cover.....	do.	do.	do.
Seventh cover.....	Lead arsenate 1-50	Lead arsenate 1-50	do.

RECOMMENDATIONS FOR THE OHIO VALLEY

The codling moth problem in the Ohio Valley has become acute in recent years and for adequate control the use of lead arsenate is necessary, for the present. This necessitates washing the fruit.

Three schedules are prescribed: The first for use in severe infestations; and the other two for use in more moderate infestations.

The second schedule will present less difficulty in residue removal, but is much more expensive than Schedule 3. Wherever the degree of infestation permits, as in the case of young orchards, the amount of lead arsenate should be reduced below that called for in Schedule 3.

<u>Spray applications</u>	<u>Schedule 1</u>	<u>Schedule 2</u>	<u>Schedule 3</u>
Calyx.....	Lead arsenate 2-50	Lead arsenate 2-50	Lead arsenate 2-50
First cover.....	do.	do.	do.
Second cover.....	Lead arsenate 1-50 plus mineral oil emulsion 3/4%	do.	do.
Third cover.....	do.	do.	do.
Fourth cover.....	Lead arsenate 1 1/2 - 50	Lead arsenate 1 1/2 - 50	Lead arsenate 1 1/2 - 50
Fifth cover.....	Nicotine sulphate 1-800 plus mineral oil 1%	Nicotine sulphate 1-800 plus mineral oil 1%	do.
Sixth cover.....	do. 1/	do.	do.

1/ An additional application may be required in some cases.

RECOMMENDATIONS FOR MIDDLE ATLANTIC STATES

In the coastal plain region of the Middle Atlantic States the codling moth is usually quite abundant, and a rather full schedule is necessary for its control. There are few orchards in which the control of the pest by the use of lead arsenate does not involve the necessity for residue removal. The adoption of washing is therefore recommended. On this basis, a 6-application schedule of lead arsenate 1-1/2 pounds to 50 gallons for the calyx application, three cover sprays for the first brood, and two for the second brood are suggested. This should give reasonably satisfactory control, and yet not leave residues so great that they can not be removed by effective cleaning methods. Shorter schedules may be effective in many orchards.

Those growers who are not equipped to wash should not use lead arsenate after the second cover spray. If previous experience under local conditions justifies it, oil or oil-nicotine may be substituted for lead arsenate.

In this region, summer apples present a difficult problem. This is especially true of tender-skinned varieties likely to be injured by the washing process. If they are not to be washed, summer apples should not receive lead arsenate after the first first-brood cover spray.

The following schedules (for winter apples) include the preceding suggestions:

<u>Spray applications</u>	<u>Schedule 1 1/</u>	<u>Schedule 2 2/</u>
Calyx.....	Lead arsenate, 1½ pounds in 50 gallons.	Lead arsenate, 1½ pounds in 50 gallons.
First cover.....	do.	do.
Second cover.....	do.	do.
Third cover.....	do.	Omit lead arsenate. <u>3/</u>
Fourth cover.....	do.	do.
Fifth Cover.....	do.	do.

1/ For growers equipped to wash.

2/ For growers not equipped to wash.

3/ Oil, oil-nicotine, or nicotine tannate may be employed if local experience justifies their use.

In the Shenandoah-Cumberland district the control of the codling moth is somewhat more readily accomplished. Growers who are equipped to wash their fruit thoroughly will probably experience no difficulty with residues if they follow the schedules now in general use. Those growers who are not equipped to wash should not continue lead arsenate beyond the second cover spray for the first brood.

Two suggested schedules for the spraying of winter apples in the Shenandoah-Cumberland region follow:

<u>Spray applications</u>	<u>Schedule 1 1/</u>	<u>Schedule 2 2/</u>
Calyx.....	Lead arsenate, 1½ lbs. to 50 gals.	Lead arsenate, 1½ lbs. to 50 gals.
First cover.....	do.	do.
Second cover.....	do.	do.
Third cover.....	do.	Omit lead arsenate <u>3/</u>

1/ For growers equipped to wash.

2/ For growers not equipped to wash.

3/ Oil or oil-nicotine may be employed if local experience justifies their use.

RECOMMENDATIONS FOR THE GREAT LAKES REGION,
NEW YORK STATE, AND NEW ENGLAND

The recommendations made for the Shenandoah-Cumberland region also apply for the most part to the Great Lakes Region, New York, and New England. In the more northern localities the codling moth problem becomes less serious, but the apple maggot is a factor on many varieties, requiring insecticidal treatment during the month of July. Growers not equipped to wash may have difficulty in dealing with this pest. Dusting has been reported as satisfactory, and from a residue standpoint is much less objectionable than spraying, especially if light applications are made.

PRACTICES OTHER THAN SPRAYING

The greatest stress should be placed on the adoption of clean-up or other means to prevent the carry-over to the next season of larvae on the trees or in connection with picking boxes, packing houses, and other storages. In the face of the present residue situation, the adoption of such methods becomes a practical necessity, and they can be employed economically because of the abundance of cheap labor.

Banding and scraping.—Properly used, chemically treated or untreated bands will capture enough worms during the season to justify their cost many times. The essential factor in the efficient use of these bands is to have the trees thoroughly scraped so that cocooning quarters away from the bands will be difficult for the worms to find. The scraping may be done at any time during the winter or spring, and is in itself of great value. All of the loose bark should be removed, and should be caught upon a canvas and burned. The scraping should be done to an inch or two below the ground line, since many worms spin their cocoons in such situations.

Orchard and packing shed sanitation.—Coarse trash (i.e. boards, broken boxes, pruning wood, etc.) on the ground in the orchards and around packing sheds should be removed and destroyed. Wherever possible, fruit containers should be placed in packing sheds, and these should be tightly closed during the spring and summer, in order to prevent the many moths which emerge from reaching the orchard. If the packing shed is of such construction that it can not readily be made moth-tight, these containers should be sterilized. A strong effort should be made to remove and destroy infested apples, particularly early in the season at the time of thinning, but also throughout the season. The frequent collection and prompt destruction of windfalls through the summer and of all culls after harvest will aid greatly in reducing infestation and the carry-over for the following season.

CONCLUDING STATEMENT

Attention to the most fundamental phases of the control program--sanitation and control of the first brood--should have an increasing benefit year by year and may make it possible to employ with good results either non-lead arsenicals or nicotine sprays.

C. L. Marlatt
Chief of Bureau